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Mathematical Reasoning
In physics and real-life context

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Abstract

This thesis is a compilation of four papers in which mathematical reasoning is examined in various contexts, in which mathematics is an integral part. It is known from previous studies that a focus on rote learning and procedural mathematical reasoning hamper students' learning of mathematics. The aims of this thesis are to explore how mathematical reasoning affects upper secondary students' possibilities to master the physics curricula, and how real-life contexts in mathematics affect students' mathematical reasoning. This is done by analysing the mathematical reasoning requirements in Swedish national physics tests; as well as by examining how mathematical reasoning affects students' success on the tests/tasks. Furthermore, the possible effect of the presence of real-life contexts in Swedish national mathematics tasks on students' success is explored; as well as if the effect differs when account is taken to mathematical reasoning requirements. The framework that is used for categorising mathematical reasoning, distinguishes between imitative and creative mathematical reasoning, where the latter, in particular, involves reasoning based on intrinsic properties.

Data consisted of ten Swedish national physics tests for upper secondary school, with additional student data for eight of the tests; and six Swedish national mathematics tests for upper secondary school, with additional student data. Both qualitative and quantitative methods were used in the analyses. The qualitative analysis consisted of structured comparisons between representative student solutions and the students' educational history. Furthermore, various descriptive statistics and significance tests were used. The main results are that a majority of the physics tasks require mathematical reasoning, and particularly that creative mathematical reasoning is required to fully master the physics curricula. Moreover, the ability to reason mathematically creatively seems to have a positive effect on students' success on physics tasks. The results indicate additionally, that there is an advantage of the presence of real-life context in mathematics tasks when creative mathematical reasoning is required. This advantage seems to be particularly notable for students with lower grades.

Keywords: Creative mathematical reasoning, Descriptive statistics, Differential item functioning, Figurative context, Imitative reasoning, Mathematical Reasoning Requirements, Mathematics tasks, National tests, Physics tasks, Real-life context, T-test, Upper secondary school.